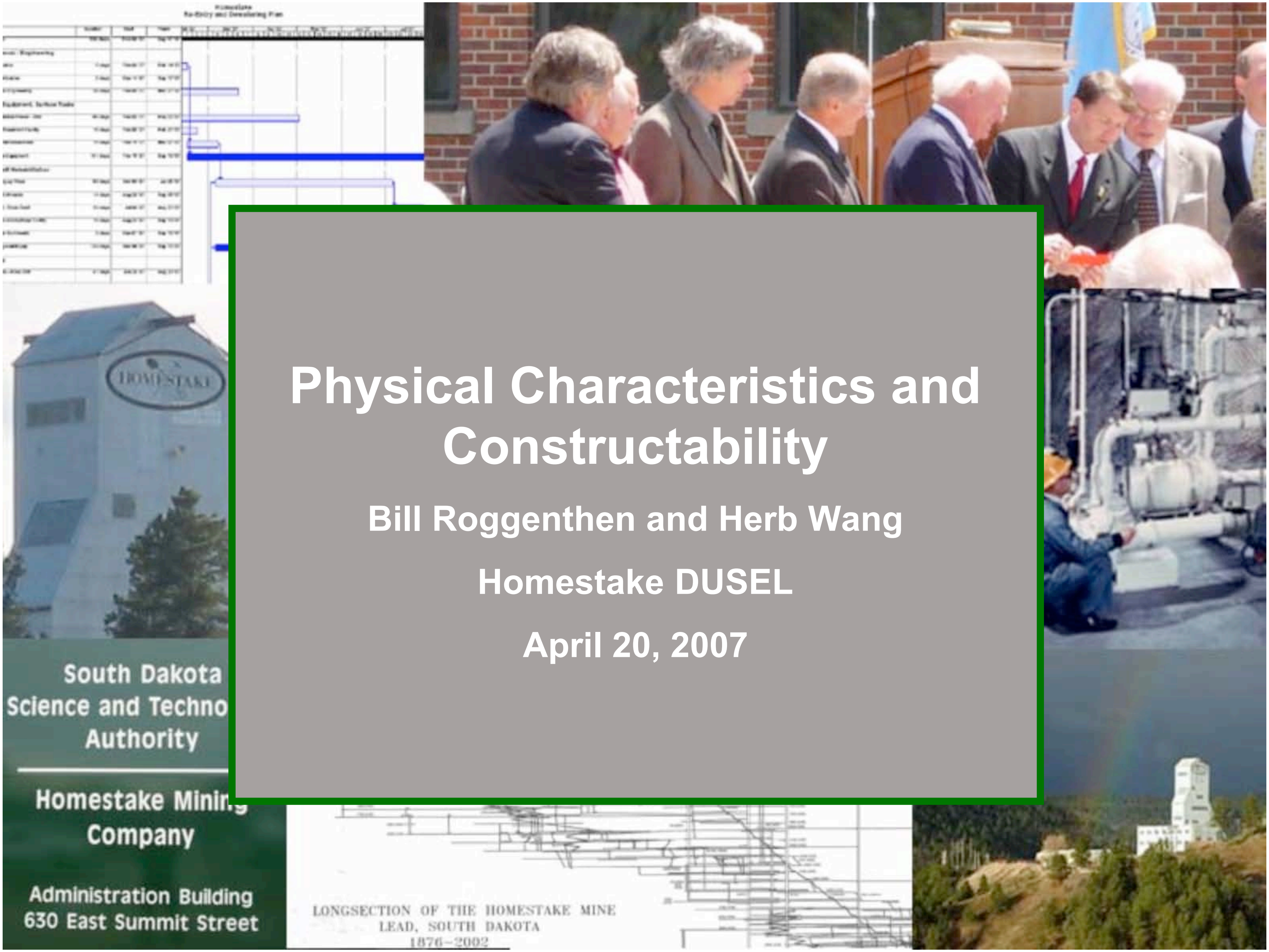


Physical Characteristics and Constructability

Bill Roggenthen and Herb Wang

Homestake DUSEL

April 20, 2007

Constructability

- Construction issues and feasibility

Several geotechnical evaluations have already concluded that Homestake DUSEL is low risk

- **RESPEC (Feb. 2001) –** Rock Mechanics Evaluations of Detector Rooms in the National Underground Laboratory at Homestake
- **Tesarik, Johnson, Zipf, and Lande (2002) –** Initial Stability Study of Large Openings for the National Underground Science laboratory at the Homestake Mine, Lead, SD
- **Dynatec (Dec. 2004) –** Feasibility Evaluation of the Conversion of the Homestake Underground Mine to the Homestake Underground Laboratory
- **Golder (May 2006) –** Geotechnical Analyses of Proposed Laboratory Excavations at the Former Homestake Mine, Lead, South Dakota

Empirical Evidence: 100+ yrs of operating experience from surface to depths of 2400 m

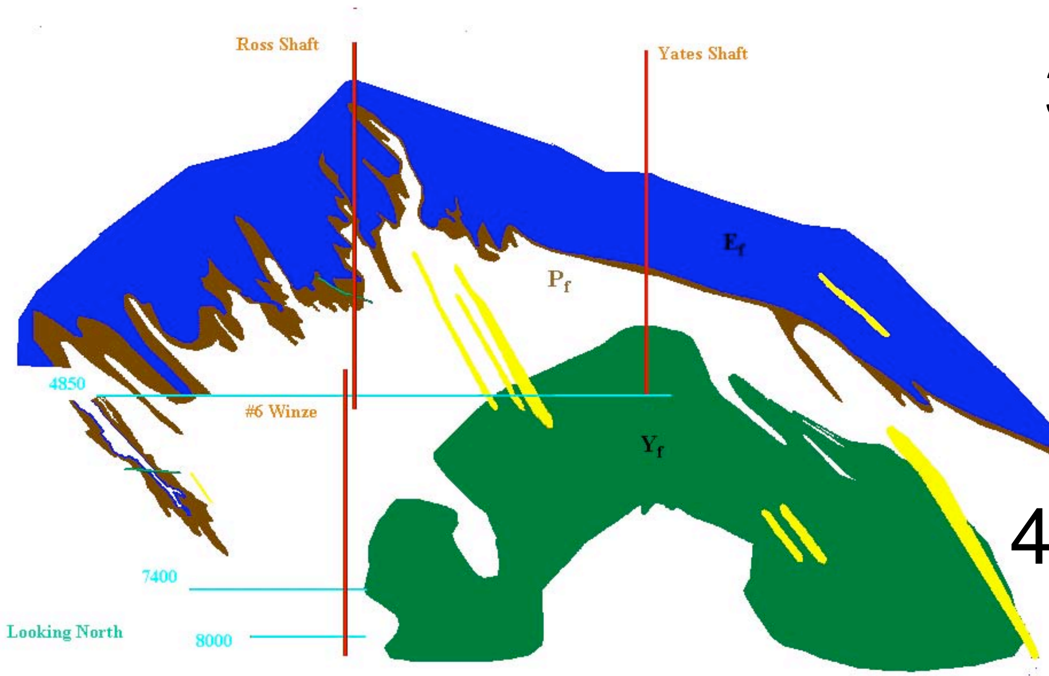
Scientific Evidence: 20+ yrs of rock mechanics research by Homestake Mining Company, Spokane Research Laboratory, U. of Utah

Predictability and Characterization

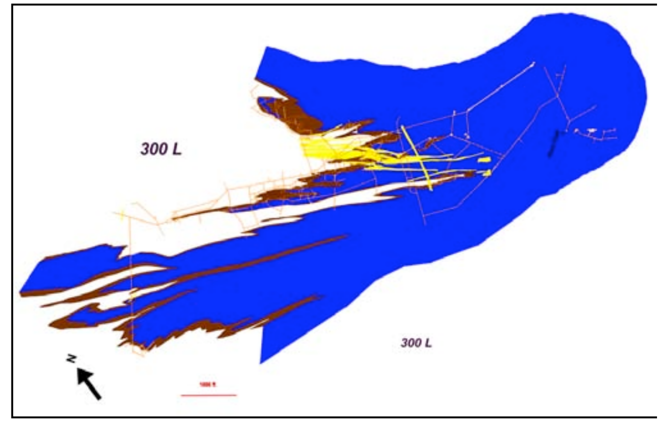
Much is known about the facility already

- Due to the 125 years of mining at Homestake, characterization of the laboratory site is extensive, both through the literature and through company reports
- Homestake contributed their 3-D database of the underground geology and infrastructure
- Transferred ~10,000 linear ft of paper records
  - Being curated as part of a separate initiative
  - Will be available for research purposes and construction of the laboratory
- Extensive core archive transferred
- Geologic maps are available for each level

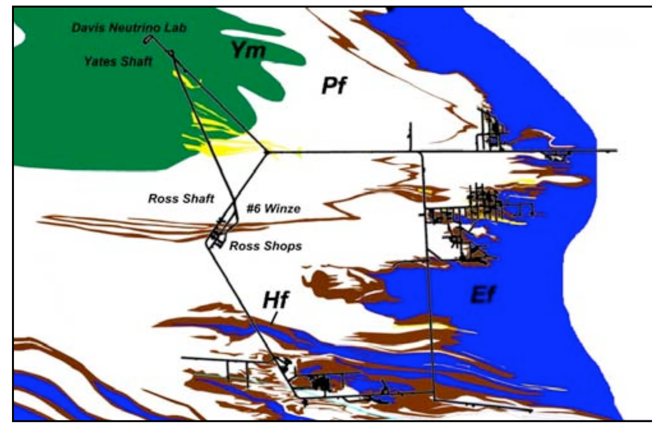
Homestake Mine
Generalized X-Section



300 L



4850 L



7400 L

- The geologic structure is nearly vertical
- Geology is predictable with depth.
- Nearly every rock type in the subsurface is likely to be encountered at the surface.

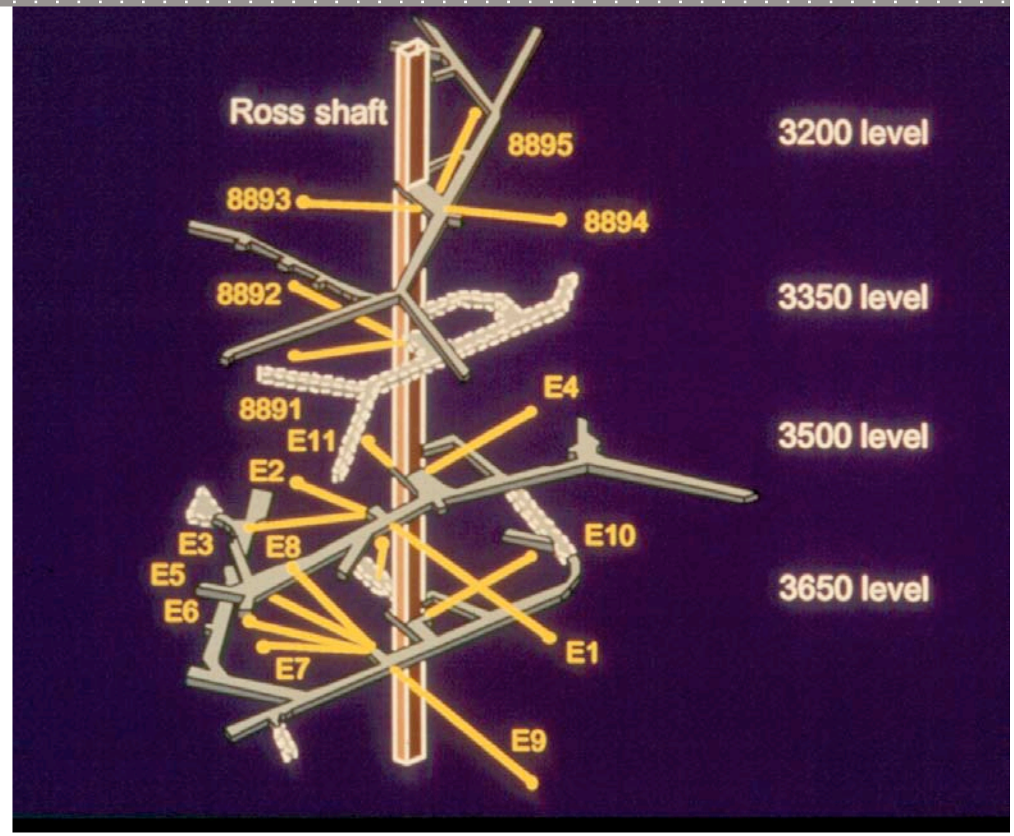
Local stress distribution is critical to rock engineering for construction of exhibition halls

Existing relations by Pariseau (1987) showed shear stresses are low. Additional stress measurements will be needed in Yates member.

$$\sigma_v = 28.28z$$

$$\sigma_H = 14{,}317 + 11.99z$$

$$\sigma_h = 834 + 12.44z$$



Stresses in kPa, depths in meters

Assessment of Historic Rock Bursts

- During the mining history at Homestake, there were few ground control problems and they could be managed.
- Conditions remained safe with proper bolting and mining cycles.
- Rock burst activity occurred when mining by the Mechanized Cut and Fill (MCF) method in the deeper mine levels (7100L) got ahead of the fill creating a pillar remnant that failed suddenly.
- When the fill operation caught up with the mining operation the mine returned to a normal non-bursting state.

Operating experience at Homestake demonstrates low risk for construction of large rooms

Level	Precedent	Proposed
4850 L.	18x6x3 m high	32x9x5 m high
(shops)	25x15x3 m	9x6x5 m
(Davis Det.)	21x9x8 m	50x20x15 m
7400/8000 L.	42x9x5 m high	32x9x5 m high
(shops)		20x6x5 m

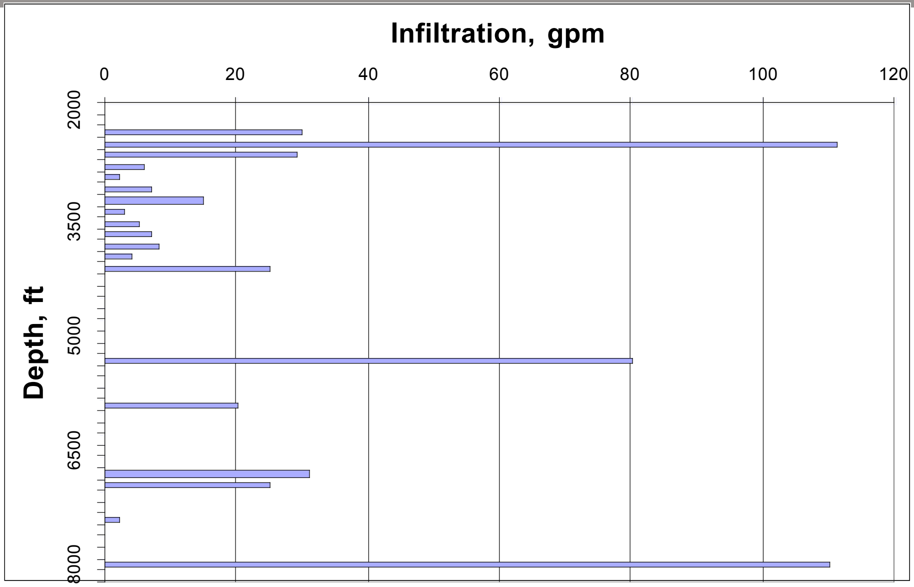
Golder Associates Conclusion about Constructability

"Based on ideal, homogeneous, good rock conditions (UCS=169 MPa), the theoretical stress-related damage (<5m depth) and failure (<1m depth) associated with a 50m cavern (H/W =2/1) are considered to be controllable with current mining/support technology."

Rock Mass Ratings

	Yates Unit	Poorman Fm
Tunneling Quality Index, Q'	**75.6**	**18.8**
Equivalent RMR	**83**	**70**
Rating	**Very good**	**Good**

Homestake was a “dry” mine



- 1990 infiltration data by HMC showed that 520 gpm of 750 gpm total is in-flow by infiltration
- Over half the flow comes from just 3 of the 40 intervals and 62% of intervals carried no flow
- Similar to Stripa where a single sheet of 375 sheets captured 10% of water, 12 captured another 50%, and 2/3 carried no flow
- 5600 level was crossed November 2006, months later than expectations

- During the last years of operation an additional 700 gal/min of water were introduced each day just for drilling.
- Water is handled routinely, up to 2200 gal/min.
- There were no physical indications of instabilities induced by water pressure, and no need for distinguishing between effective and total stress in deformation analysis.

Synergism

- Science and Engineering Before, During, and After Construction

Long-term Science Goals for Rock Mechanics and Hydrology Program

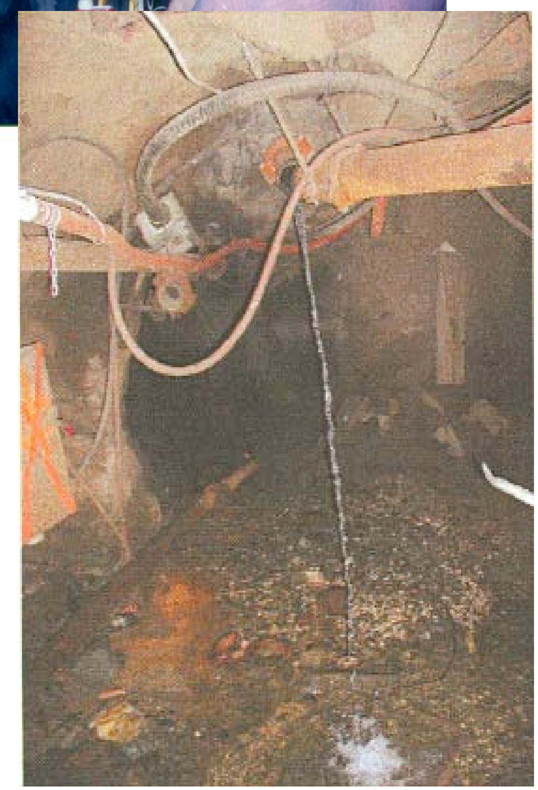
- How do stresses, rock properties, and hydrologic properties vary with scale?
- How does recharge occur in a mountainous system?
- Is crust at Homestake critically stressed as in other stable, intraplate areas?
- Do critically-stressed faults dominate fluid flow?
- How does the spatial distribution of Tertiary fractures relate to Tertiary intrusions?
- How does hydrology relate to geomicrobiology?

Unprecedented opportunity to characterize, monitor, and model fractures, stresses, and hydrology over a large volume to 8,000' depth.

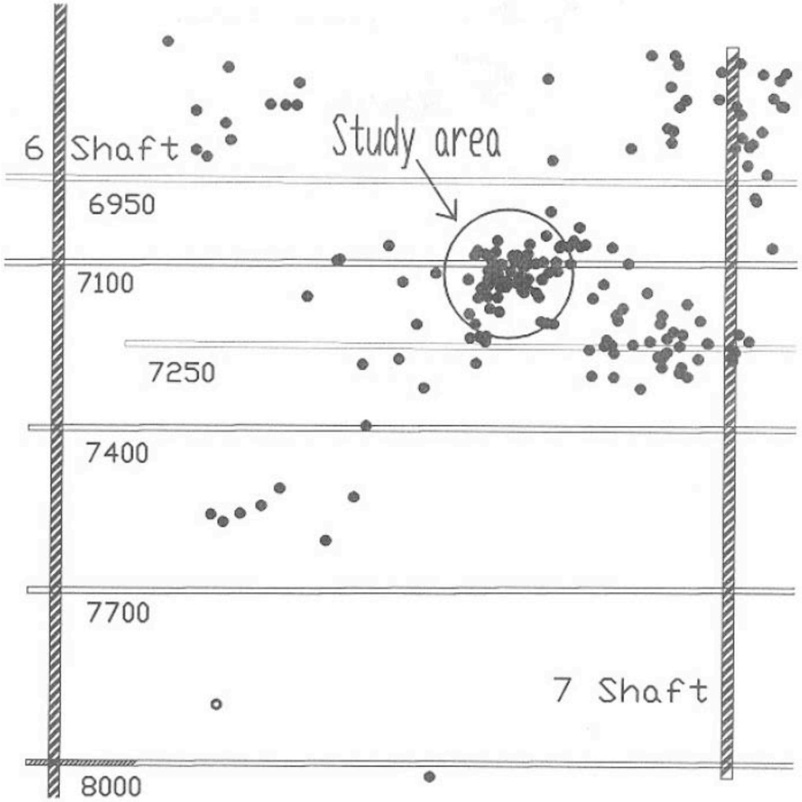
Geoscience and Geoengineering Time Line

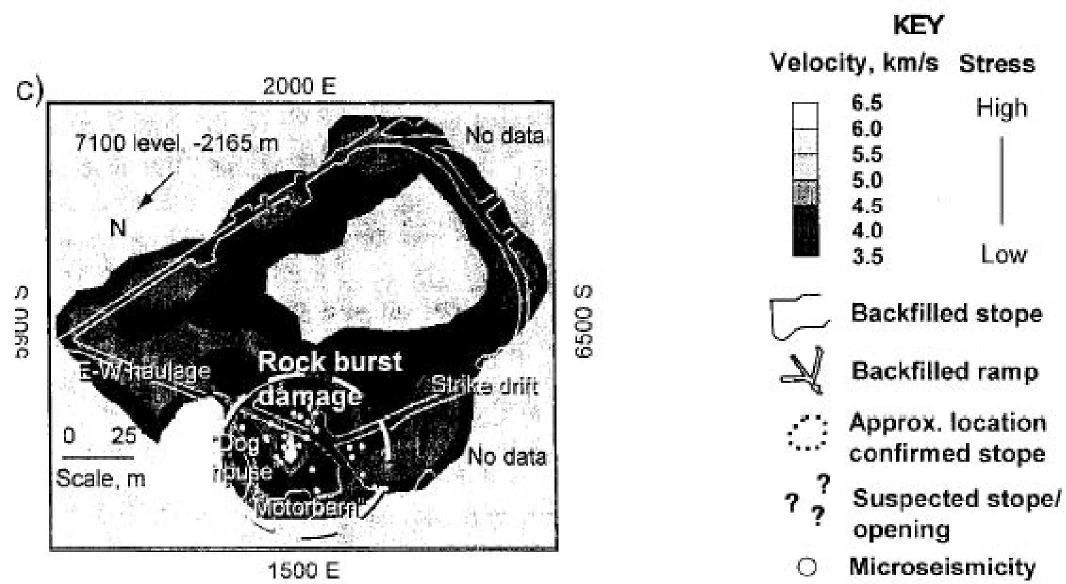
1. **Re-entry, Early Implementation Program, and DUSEL Construction Phases:** Geotechnical data collected during *re-entry and dewatering* provide baseline data to initiate the rock mechanics and hydrology scientific program while jump starting basic geotechnical data needed for physics lab construction.

2. **DUSEL Operational Phase**: Safe operation of exhibition halls will benefit from long-term geophysical and geotechnical monitoring operated jointly with the geoscientific studies, e.g., acoustic tomography, deformation, fluid flow, and microseismicity.



Example: USBM rock burst study showed how seismicity and tomography can be used as monitoring tool for failure



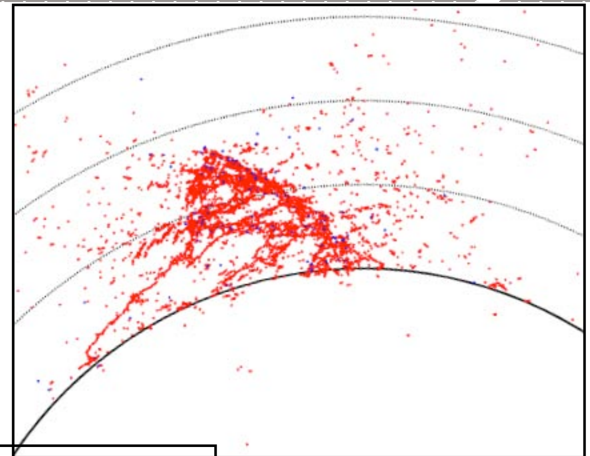


USBM installed 16-accelerometer array in 1990s and recorded 1100 events (Filigenzi and Girard, 1995). Fills gap in spatial-scale for understanding seismic “b-value.”

Microseismic activity correlated with regions of intermediate velocity, but high-velocity gradient (Friedel et al.,1996)

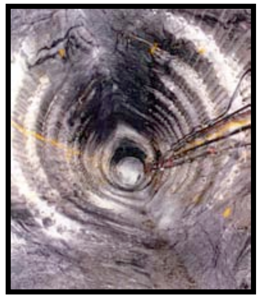
Example: Canadian URL mine-by study showed what can be learned scientifically when excavations are being made

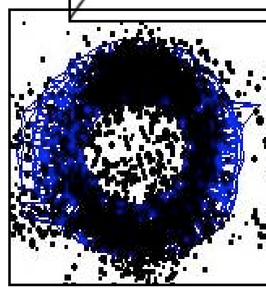
Excavation damage



PFC simulation

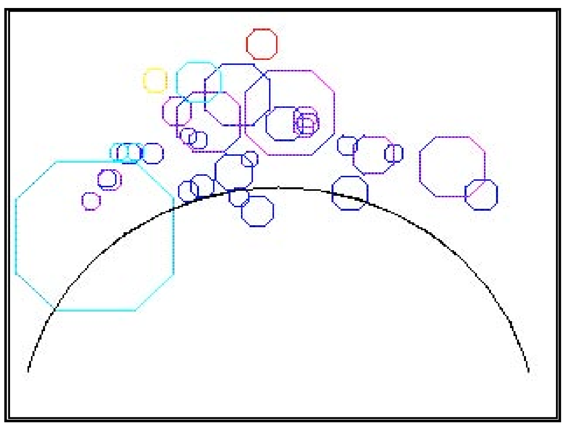
Potyondy and Cundall, 2001

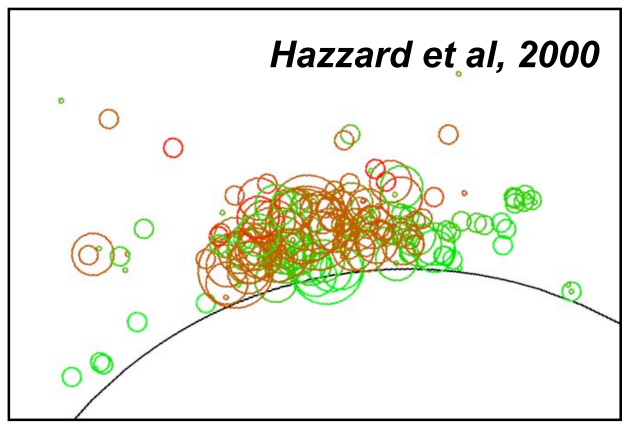


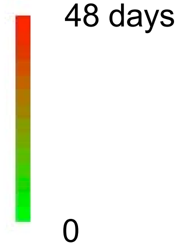


Recorded seismicity

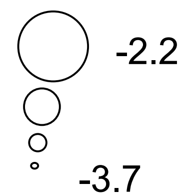
PFC synthetic seismicity







Moment magnitude



Conclusion: Physical characteristics are outstanding for science and construction

- Geology predictable
- Mining history, core repository, and Vulcan database are invaluable resources for design and construction
- Low U and Th in Yates unit
- Geotechnical considerations are favorable
  - Stresses
  - Rock properties
  - Water conditions

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in 7400L Shop Area